DEMONSTRATION THAT THE U.S. ENVIRONMENTAL PROTECTION AGENCY MUST GRANT CALIFORNIA A WAIVER FROM THE FEDERAL REFORMULATED GASOLINE OXYGEN MANDATE ON REMAND FROM THE U.S. COURT OF APPEALS FOR THE NINTH CIRCUIT

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SUMMARY

The new data and the discussion presented in the sections that follow lead to the conclusion that, in California, the federal RFG oxygen mandate results in increases in the combined of NOx and VOC emissions, and these emission increases prevent or interfere with attainment of the PM_{10} and $PM_{2.5}$ NAAQS. As shown in Section II, attaining and maintaining the NAAQS for PM_{10} and $PM_{2.5}$ is important to the health and welfare of the people of California.

In addition, this analysis also clearly demonstrates that the federal RFG oxygen mandate additionally prevents or interferes with attainment of the ozone NAAQS in the state's ozone nonattainment areas. In all scenarios the federal RFG oxygen mandate shows substantial increases in the combined emissions of NOx and VOC – the two principal precursors of ozone.

Based on the data and analysis now available, California has adequately demonstrated that a waiver will assist the State's efforts to attain and maintain the NAAQS for ozone. Under these circumstances, where it has been shown that the federal RFG oxygen mandate clearly interferes with attainment of the PM_{10} and $PM_{2.5}$ NAAQS and likely interferes with attainment of the ozone NAAQS, the Clean Air Act provides no basis for U.S. EPA to deny a waiver based on the unlikely possibility that a waiver might hinder ozone attainment.

U.S. EPA should not ignore the fact that the State of California, the ARB, and the South Coast Air Quality Management District have all concluded that a waiver is needed to avoid the emissions increases and degradation of air quality that results in California from the federal RFG oxygen mandate. Section 211(c)(4)(B) of the Clean Air Act recognizes California's longstanding expertise in regulating motor vehicle fuels to reduce emissions – and the unique air quality problems the State faces – by making California the only state to enjoy a blanket exemption from federal preemption of its motor vehicle fuels regulations. The state has been a pioneer in reducing emissions through standards for gasoline, and was already limiting summertime RVP in the early 1970's. In this context, U.S. EPA must give some deference to California's determinations on the air quality impacts of the oxygen mandate.

Finally, in addition to the technical facts that support granting the waiver U.S. EPA should also recognize the substantial cost savings to Californians that will accompany the emission reductions that result from the waiver. This is not the normal case where emission reductions come at a significant cost. The emissions reductions will instead

come with an actual cost savings to the people of California – estimated several hundreds of millions of dollars annually. The Court requires that U.S. EPA reconsider this matter. Given the facts and analysis now available we believe that U.S. EPA accordingly has only one justifiable option at this time: to respond to the Court's remand by granting the waiver.

I. BACKGROUND – THE WAIVER DENIAL AND THE NINTH CIRCUIT COURT OF APPEALS DECISION

Approximately 80 percent of the gasoline sold in California is now subject to the federal Reformulated Gasoline (RFG) requirements. Under section 211(k)(2)(B) of the Clean Air Act (CAA), one of the requirements for federal RFG is that it must contain at least 2.0 weight percent (wt.%) oxygen, which is added to gasoline by an oxygenate such as Methyl Tertiary-Butyl Ether (MTBE) or ethanol. However, in that subsection Congress expressly authorized the United States Environmental Protection Agency (U.S. EPA) to grant a waiver from the oxygen mandate for federal RFG if compliance with the requirement in an area "prevent[s] or interfere[s] with the attainment by the area of a national ambient air quality standard [NAAQS]."

California originally requested the waiver of the federal RFG oxygen mandate in an April 12, 1999 letter, and the Air Resources Board (ARB) made several supplemental submittals. The U.S. EPA deemed California's waiver application complete in a February 14, 2000 letter from Assistant Administrator Robert Perciasepe to California Environmental Protection Agency (Cal-EPA) Secretary Winston Hickox. The justification for a waiver results from the fact that refiners producing gasoline for the federal RFG areas in California must meet the California Reformulated Gasoline (CaRFG) standards as well as the federal RFG standards. The U.S. EPA ultimately agreed with the ARB's conclusion that – because of the way the California Phase 3 Reformulated Gasoline (CaRFG3) Predictive Model works and the effect of gasoline's oxygen content on oxides of nitrogen (NOx) emissions – the CaRFG3 produced by refiners when they also have to meet the federal RFG oxygen mandate will result in greater NOx emissions than will be the case with a waiver. NOx emissions contribute to both ozone and particulate matter (PM) pollution. Emissions of volatile organic compounds (VOC) and to a much less extent emissions of carbon monoxide (CO) interact in the atmosphere with nitrogen dioxide (NO_2) to form elevated levels of ozone.

In its waiver analysis, the U.S. EPA concluded that along with increasing NOx emissions in California, the federal oxygen mandate reduces CO emissions and there is uncertainty whether it reduces or increases VOC emissions. The U.S. EPA interpreted CAA section 202(k)(2)(B) to mean that the agency should grant a waiver only if it is "clearly demonstrated" that the waiver will aid in attainment of a NAAQS, and will not hinder the attainment of the ambient standards for any other pollutants.[1] The agency decided that the uncertainty regarding the effects of a waiver on attaining the ozone

[1] U.S. EPA's June 2001 Technical Support Document (TSD), Appendix A, page 145.

standard did not justify issuance of a waiver on the basis of impacts on ozone pollution. The U.S. EPA further concluded that once it found it should not issue the waiver based on impacts on ozone the agency did not need to further consider whether the effect of the oxygen mandate on attainment of the PM NAAQS justified a waiver. The Ninth Circuit Court of Appeals (the Court) concluded that the U.S. EPA abused its discretion by refusing to evaluate the effect that an oxygen waiver would have on California's efforts to comply with the PM NAAQS. The Court stated, "By ignoring the evidence concerning the effects of a waiver on PM, the U.S. EPA refused to make the statutorily-directed determination whether denial of the State's waiver request would interfere with attainment of a NAAQS."[2] The Court explained:

> The EPA's current approach also cripples the goals of the CAA when, as in the current situation, the effects of a waiver on one NAAQS are merely uncertain, not necessarily negative. Although California was unable to clearly demonstrate that the oxygen requirement would interfere with ozone standards, the EPA found no conclusive evidence that a waiver would be harmful to ozone. The effects of a waiver on ozone are uncertain at worst. The EPA nevertheless refused to consider the significance of the PM evidence. It adhered to this refusal even though the benefit of a waiver to the PM NAAQS could conceivably outweigh the uncertain effects of that waiver on ozone levels.[3]

The Court vacated the Administrator's June 12, 2001 denial of our waiver request, and remanded the matter to the U.S. EPA with instructions to review the request with full consideration of the effects of a waiver on both the ozone and the PM NAAQS.

II. ATTAINING AND MAINTAINING THE NAAQS FOR PM_{10} AND $PM_{2.5}$ IS IMPORTANT TO THE HEALTH AND WELFARE OF THE PEOPLE OF CALIFORNIA

The U.S. EPA administers two primary NAAQS for particulate matter with a nominal diameter of 10 microns or less (PM_{10}) – an annual standard of 50 microns per cubic meter ($\mu g/m^3$), and a 24-hour standard of 150 $\mu g/m^3$. The agency also administers two primary NAAQS for particulate matter with a nominal diameter of 2.5 microns or less ($PM_{2.5}$) – an annual standard of 15.0 $\mu g/m^3$, and a 24-hour standard of 65 $\mu g/m^3$.[4]

The federal RFG oxygen mandate applies to all gasoline sold in the following areas of California: (1) Los Angeles, Ventura, Orange, and most of San Bernardino and Riverside Counties (which include the South Coast Air Basin, or SCAB), (2) San Diego County, (3) the Sacramento Metro nonattainment area, and (4) the San Joaquin Valley nonattainment area (which includes the San Joaquin Valley Air Basin, or SJVAB). About 80 percent of the state's gasoline is sold in these areas.

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[2] 336 F.3d at 977.
[3] *Id.*
[4] 40 Code of Federal Regulations (CFR) §§ 50.6 and 50.7.

The South Coast Air Basin and the San Joaquin Valley Air Basin are both currently designated by U.S. EPA as "serious" nonattainment for the federal PM_{10} standard, and Sacramento County is designated as "moderate" nonattainment.[5] San Diego County was among the five areas in the nation recently identified by the U.S. EPA as having "a significant risk of failing to attain and maintain the PM_{10} NAAQS without further reductions in emissions."[6]

The U.S. EPA has not yet made nonattainment designations for the $PM_{2.5}$ standard, but has announced its intention to do so in 2004.[7] Monitoring data from 2000-2002 in California indicates that the South Coast and San Joaquin Valley air basins meet the criteria for nonattainment designations for both the 24-hour and annual $PM_{2.5}$ NAAQS, and San Diego County meets the criteria for a nonattainment designation for the annual $PM_{2.5}$ NAAQS.[8] In both the South Coast and the San Joaquin Valley, far more sites exceed the annual and 24-hour $PM_{2.5}$ NAAQS than is the case with the PM_{10} NAAQS.[9] In addition, relatively high 24-hour measurements of $PM_{2.5}$ are found in the Sacramento Valley Air Basin.

The U.S. EPA clearly recognizes that attainment and maintenance of the PM NAAQS is important to public health. In 2000, the agency adopted its "Tier 2" motor vehicle emissions standards, which primarily target NOx reductions from the same light-duty vehicles whose NOx emissions are increased by the federal RFG oxygen mandate. In the Preamble to the final rule, the U.S. EPA identified the harmful effects of exposure to elevated levels of PM:

> Particulate matter, like ozone, has been linked to a range of serious respiratory health problems. Scientific studies suggest a likely causal role of ambient particulate matter in contributing to a series of health effects. The key health effects categories associated with particulate matter include premature mortality, aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits, school absences, work loss days, and restricted activity days), changes in lung function and increased respiratory symptoms, changes in lung tissues and structure, and altered respiratory defense mechanisms. PM also causes damage to materials and soiling. It is a major cause of substantial visibility impairment in many parts of the U.S.
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> Motor vehicle particle emissions and the particles formed by the transformation of motor vehicle gaseous emissions tend to be in the fine particle range. Fine particles are a special health concern because they

[5] 40 CFR § 81.305. The South Coast and San Joaquin Valley exceed both the annual and 24-hour $PM10_{10}$ standards, while Sacramento has exceeded the 24-hour $PM10_{10}$ standard.
[6] 65 Federal Register (FR) 6698, 6719 (Feb. 10, 2000).
[7] 4/1/03 Memorandum from U.S. EPA Assistant Administrator Jeffrey R. Holmstead re Designations for the Fine Particulate National Ambient Air Quality Standards.
[8] Area Status for $PM_{2.5}$ National Ambient Air Quality Standards, 6/6/03 draft.
[9] For instance, in 2002 15 out of the 16 sites in the South Coast exceeded the annual $PM_{2.5}$ NAAQS, as all 11 of the sites in the San Joaquin Valley. See Attachment 1.

easily reach the deepest recesses of the lungs. Scientific studies have linked fine particles (alone or in combination with other air pollutants), with a series of significant health problems, including premature death; respiratory related hospital admissions and emergency room visits; aggravated asthma; acute respiratory symptoms, including aggravated coughing and difficult or painful breathing; chronic bronchitis; and decreased lung function that can be experienced as shortness of breath.[10]

III. THE FEDERAL RFG OXYGEN MANDATE CLEARLY PREVENTS AND INTERFERES WITH ATTAINMENT OF THE NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PM_{10} AND $PM_{2.5}$ IN CALIFORNIA'S FEDERAL RFG AREAS

A. The U.S. EPA Has Already Determined That the Federal RFG Oxygen Mandate Results In a Substantial Increase in NOx Emissions In California

Almost one-half of the U.S. EPA's June 2001 TSD (Section III A and B, pages 18-78) addressed the impact of the federal RFG oxygen requirement on NOx emissions in California. The agency's analysis recognized California's unique setting in which refiners will have to meet the CaRFG3 standards as well as the federal RFG standards. Central to the agency's ultimate conclusions on NOx impacts was a set of 12 potential comparison scenarios described on pages 74-77 of the TSD. Table 31 of the TSD shows that in every one of the twelve scenarios, the federal RFG oxygen mandate results in increases in NOx emissions in the South Coast Air Basin. Those NOx emission increases are substantial – ranging from 5 tons per day (tpd) to 11 tpd, with an average increase of 7 tpd. This average increase is comparable to the NOx emissions from fuel combustion in all electric utility power plants in the South Coast.

The key point here is that no additional time-consuming work is necessary on the issue of NOx emission impacts. While the ARB staff believes the actual NOx emissions impacts are probably greater than those set forth in the TSD, the conclusions on NOx in the TSD are sufficient for the U.S. EPA to conclude that granting the waiver will assist California in its effort to reduce NOx emissions.

B. The NOx Emission Increases That the U.S. EPA Has Already Identified Necessarily Increase Ambient Concentrations of PM_{10} and $PM_{2.5}$ in California

Although the U.S. EPA never addressed the impact of the NOx emissions increase from the federal RFG oxygen mandate on PM concentrations in its TSD[11] or elsewhere, this issue is straightforward and can easily and quickly be resolved by the agency. Emissions of NOx have a substantial adverse impact on ambient concentrations of PM_{10} and $PM_{2.5}$ in California. In fact, achieving reductions in NOx emissions is the most

[10] 65 FR 6698, 6717 (February 10, 2000).
[11] See TSD fn. 89 on p. 128: "We need not discuss the technical issues associated with an expected reduction in NOx [from a waiver] and any associated reduction in PM."

important control strategy in California's plans to attain and maintain the NAAQS for PM_{10}, and this will undoubtedly be the case with respect to the $PM_{2.5}$ NAAQS as well.

The main sources of NOx emissions are anthropogenic. NOx emissions are produced almost exclusively by combustion processes. During combustion, oxygen reacts with nitrogen to form nitric oxide (NO), nitrogen dioxide (NO_2), and relatively small amounts of other compounds of oxygen and nitrogen. When emitted to the atmosphere, these nitrogen by-products – which are collectively called NOx – are oxidized to form nitric acid. The nitric acid then reacts with gaseous ammonia to form ammonium nitrate. Since gaseous ammonia is generally in abundance in the California areas in question, the formation of ammonium nitrate from the nitric acid-gaseous ammonium reaction mechanism is dependent on the level of NOx emissions. Although VOC can play a role in the oxidation of NOx to nitric acid, ammonium nitrate is primarily responsive to reductions in NOx emissions, with minimal response to changes in VOC emissions.

Secondary ammonium nitrate comprises a large fraction of PM_{10} and even a larger fraction of $PM_{2.5}$ mass in California. The South Coast and San Joaquin Valley have the highest concentrations of ammonium nitrate. Roughly 20 to 30 percent of the annual average PM_{10} mass and 30 to 40 percent of the annual average $PM_{2.5}$ mass is ammonium nitrate in these areas. Basin-high annual average PM_{10} ammonium nitrate concentrations ranged from 11 $\mu g/m^3$ in the San Joaquin Valley to 27 $\mu g/m^3$ in the South Coast. The ammonium nitrate fraction is even larger on the peak PM days and was found to contribute up to 57 percent of PM_{10} mass and 84 percent of $PM_{2.5}$ mass. Peak 24-hour average PM_{10} ammonium nitrate levels in the South Coast Air Basin and the San Joaquin Valley Air Basin reached over 100 $\mu g/m^3$. With respect to $PM_{2.5}$, ammonium nitrate concentrations alone can exceed the federal $PM_{2.5}$ standards. A fuller discussion can be found in Attachment 1.

As discussed in more detail below, the PM_{10} nonattainment plans recently prepared for the South Coast and San Joaquin Valley Air Basins demonstrate that NOx emissions control is the most effective way to achieve attainment, along with reductions in primary PM_{10} components. It is clear that there are no significant technical issues regarding the relationship of NOx emissions to PM_{10} and $PM_{2.5}$ concentrations in California's federal RFG areas, and the U.S. EPA should be able to make the necessary determinations regarding that relationship without delay.

C. The Net Effect of the Federal RFG Oxygen Mandate on Emissions of All Pollutants In California Is To Increase Ambient PM_{10} and $PM_{2.5}$

While U.S. EPA concluded in its prior evaluation of the California waiver request that the federal RFG oxygen mandate increases NOx emissions in California, the agency also concluded that the mandate reduces emissions of CO and that its impact on VOC emissions was uncertain. This Section addresses the potential impact that changes in CO and VOC emissions caused by the oxygen mandate could have on ambient PM_{10} and $PM_{2.5}$, and the cumulative impact on particulate from changes in emissions of NOx, VOC and CO.

1. The Reduction in CO Emissions Resulting From the Federal RFG Oxygen Mandate Does Not Affect Ambient PM_{10} and $PM_{2.5}$ in California

The ARB has consistently acknowledged that the 2.0 wt.% minimum oxygen requirement in the federal RFG program reduces CO emissions from the existing fleet of vehicles on the road today. That is why the California Phase 2 and Phase 3 RFG standards impose a minimum oxygen requirement from November through February – when ambient CO concentrations are the highest – in the counties of Los Angeles, Orange, Riverside, San Bernardino, and Ventura (§§ 2260(a)(32.5) and 2262.5(a), title 13, California Code of Regulation (CCR)). These counties include the only remaining federal CO nonattainment area in the State.[12] In fact, California also imposes a minimum oxygen requirement from November through February in Imperial County as well. (§ 2262.5(a), title 13, CCR). This is because while Imperial County is designated as "unclassified" with respect to attainment of the NAAQS for CO, the ARB has designated it as being in nonattainment of the State ambient air quality standard for CO.[13]

While CO emissions do play a small role in ozone formation due to CO's limited reactivity, they do not appreciably affect ambient PM_{10} or $PM_{2.5}$ concentrations[14]. The simplest carbon containing molecule in the atmosphere, CO participates in the conversion of free radicals (hydroxyl radical to hydroperoxyl radical) that enhance the oxidation of NOx to nitric acid. However, there are several other paths to the same radical conversion and the role of CO in the oxidation of NOx to nitric acid is minor in the polluted atmosphere. CO does not play a direct role in the oxidation of VOCs into secondary organic aerosols[15].

The ARB staff is not aware of any guidance ever issued by the U.S. EPA indicating that CO emissions contribute to PM. To staff's knowledge, no PM_{10} attainment plan has ever included CO controls as a PM reduction strategy. Certainly the PM_{10} attainment plans recently prepared for the South Coast and San Joaquin Valley air basins do not attribute PM_{10} reductions to the CO reductions that continue to occur in those areas due to motor vehicle fleet turnover.

In light of these considerations, there would be no justification for delaying a waiver in order to analyze the potential impact of the CO emission increases that would result from a waiver on attainment and maintenance of the PM_{10} or $PM_{2.5}$ standards in California.

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[12] 63 FR 15305-15312 (March 31, 1998).

[13] A waiver of the federal RFG oxygen mandate would in no way hinder attainment of the NAAQS for CO because the CaRFG regulations will continue to require the use of oxygen in California's one CO nonattainment area during the season when exceedances of the CO NAAQS have occurred.

[14] Seinfeld, "Atmospheric Chemistry and Physics of Air Pollution", 1998

[15] "Particulate Matter for Policy Makers. A NARSTO Assessment", February 2003.

2. *Even Under the U.S. EPA's Worst-Case Projections of Potential VOC Increases In Certain Waiver Scenarios, the Net Effect of the Federal RFG Oxygen Mandate Is Clearly to Increase Concentrations of PM_{10} or $PM_{2.5}$ in California*

As discussed in Section V below, it is very unlikely given current information that a waiver of the federal RFG oxygen mandate will result in any increase in VOC emissions. However, even using U.S. EPA's worst-case projections in the TSD, it is clear that the net effect of the federal RFG oxygen mandate on both NOx and VOC emissions is to increase PM_{10} and $PM_{2.5}$ concentrations in California.

While VOC emissions have some effect on ambient PM_{10} or $PM_{2.5}$, on a pound-for-pound basis the contribution is much smaller than the contribution from NOx emissions. Table 31 of the TSD identified the VOC impacts from a waiver at various commingling-related Reid vapor pressure (RVP) boosts for the 12 specified scenarios. The absolute worst case shown in Table 31 for VOC increases resulting from a waiver is a Scenario 1 VOC increase of 9.23 tpd when there is a 0.2 psi boost in RVP due to commingling. Scenario 1 also shows a NOx emissions reduction of 6.60 tpd. Even in these worst-case circumstances, the combined impacts of the changes in NOx and VOC emissions due to a waiver have the demonstrable net effect of an overall reduction in PM concentrations.

The attainment demonstration procedures contained in the San Joaquin Valley and South Coast PM_{10} attainment plans provide a sophisticated means of comparing the potential impact of changes in NOx and VOC emissions on the PM_{10} concentrations in those two areas. The ARB staff has estimated the impact of a waiver on the peak annual average PM_{10} concentration in the South Coast Air Basin by applying a simple linear rollback approach with the Urban Airshed Model Long Term (UAM-LT) model results that were used in the attainment demonstration in the South Coast PM_{10} plan.[16] The incremental impacts of changes in NOx and VOC emissions on PM_{10} due to oxygenated gasoline were estimated by changing the projected NOx and VOC emissions in the rollback analysis by 10 tons per day. The results for the South Coast show that changing NOx emissions by 10 tons per day would change the peak annual PM_{10} concentration by 0.12 $\mu g/m^3$, while changing VOC emissions by the same amount would only result in a 0.011 $\mu g/m^3$ change in PM_{10} – over an order of magnitude less. Thus under U.S. EPA's <u>worst-case</u> Scenario 1, the 6.60 tpd reduction in NOx emissions from a waiver would result in a reduction in peak annual PM_{10} concentrations of 0.08 $\mu g/m^3$, while the VOC emissions increase of 9.23 tpd would increase annual PM_{10} concentrations by 0.01 $\mu g/m^3$, resulting in a net reduction in peak annual PM_{10} concentrations of 0.07 $\mu g/m^3$.

The ARB staff has also estimated the impact on the peak 24-hour PM_{10} value in the San Joaquin Valley following the procedure outlined in the San Joaquin Valley plan, which used both Chemical Mass Balance (CMB) modeling with grid-based

[16] For the South Coast Air Basin, the ARB staff evaluated impacts on attainment of the annual PM_{10} standard because the annual standard is the most difficult to attain there. The highest annual design value of 56.8 $\mu g/m^3$ at Riverside-Rubidoux was used in the analysis.

photochemical aerosol chemistry modeling analysis (UAM-Aero), combined with proportional rollback to demonstrate attainment.[17] The results show that while changing NOx emissions by 10 tpd a day would change the peak 24-hour PM_{10} concentration by 1.5 μg/m^3, changing VOC emissions by the same amount would only result in a 0.14 μg/m^3 change in the peak 24-hour PM_{10} concentration. Again, there is an order of magnitude difference between the impact of changes in NOx emissions and changes in VOC emissions.

The relative importance of NOx and VOC controls as PM reduction strategies is also illustrated by the role they play in the two recently-prepared PM_{10} attainment plans. In the San Joaquin Valley Air Basin, approximately 19 μg/m^3 in PM_{10} reductions came from reductions in ammonium nitrate and 2 μg/m^3 came from reductions in secondary organic carbon. In the South Coast, approximately 13 μg/m^3 in PM_{10} reductions came from reductions in ammonium nitrate and 0.2 μg/m^3 came from reductions in secondary organic carbon.

Emission reductions that lower PM_{10} concentrations will also lower $PM_{2.5}$ concentrations. Because almost all of the ammonium nitrate and secondary organic carbon can be found in the $PM_{2.5}$ size fraction, the results presented for PM_{10} are also applicable for $PM_{2.5}$.

Attachment 1 provides the details on the various estimates in this Section regarding the impacts of NOx and VOC emissions.

IV. THE SUBSTANTIAL NET INCREASES IN PM THAT RESULT FROM THE FEDERAL RFG OXYGEN MANDATE, COUPLED WITH THE CURRENT PM NONATTAINMENT STATUS OF MOST FEDERAL RFG AREAS IN CALIFORNIA, NECESSARILY MEAN THAT THE FEDERAL RFG OXYGEN MANDATE IS PREVENTING OR INTERFERING WITH ATTAINMENT OF THE NAAQS FOR PM_{10} or $PM_{2.5}$ IN THE STATE

As discussed above, the substantial NOx increases that result from the federal RFG oxygen mandate contribute to PM_{10} or $PM_{2.5}$ concentrations in the federal RFG areas in California. It necessarily follows that these NOx increases prevent or interfere with attainment of the PM_{10} or $PM_{2.5}$ NAAQS in those areas where the ambient standards are not presently attained.

This conclusion is not negated by the fact that the PM_{10} State Implementation Plans for the San Joaquin Valley and South Coast air basins ultimately demonstrate attainment with the PM_{10} NAAQS, for three reasons. First, both air basins are presently in nonattainment of the NAAQS for PM_{10}, and the federal RFG oxygen mandate is resulting in real and immediate increases in PM. They would be closer to attaining the NAAQS for PM_{10} right now if it was not for the additional NOx emissions caused by the

[17] The 24-hour PM_{10} standard is the most difficult to attain in the San Joaquin Valley. The ARB staff therefore evaluated the potential impacts on 24-hour concentrations using the highest 24-hour design value at Bakersfield-Golden of 205 μg/m^3.

federal RFG oxygen mandate. Second, the attainment plans for the PM_{10} NAAQS in the South Coast and San Joaquin Valley air basins are based on an on-road vehicle emissions inventory model (EMFAC model) that takes into account CaRFG3 program. Thus denial of the waiver will prevent the two air basins from realizing the full emission benefits of the program. Finally, attainment with the NAAQS for $PM_{2.5}$ has not yet been demonstrated and significant additional unidentified control measures are needed for attainment. Thus the federal oxygen mandate clearly prevents or interferes with attainment of the $PM_{2.5}$ NAAQS.

V. IN LIGHT OF NEW EVIDENCE THE PREVIOUS U.S. EPA FINDING THAT A WAIVER OF THE RFG OXYGEN MANDATE MIGHT ADVERSELY AFFECT VOC EMISSIONS AND THEREFORE INCREASE OZONE LEVELS CAN NO LONGER BE JUSTIFIED

Since the U.S. EPA's original denial of the waiver, the available data on the impact of a waiver on VOC emissions has been supplemented in two important areas: (a) the VOC permeation emission increases from nonroad equipment and gasoline cans that result from an increased use of ethanol in gasoline, and (b) the degree to which a waiver will result in increased emissions of VOC due to "commingling." When the impact of those changes in emissions are taken into account, it is abundantly clear that a waiver will not increase VOC emissions and therefore would not hinder attainment of the ambient ozone standard in California.

A. Increases in Evaporative VOC Emissions Due to Permeation When Gasoline Containing Ethanol Is Used In Nonroad Equipment and Portable Gasoline Containers

In its 2001 waiver analysis, the U.S. EPA used the ARB's estimates regarding increases in permeation emissions from motor vehicles ethanol-blended gasoline. New test data now allow the quantification of the significant permeation emission increases from nonroad equipment and gasoline cans that result from application of the federal RFG oxygen mandate in California.

It is well known that the presence of ethanol in gasoline can increase emissions through a process known as permeation. Permeation emissions occur when fuel compounds found in gasoline permeate through the non-metallic fuel system components, such as hoses and gaskets. Increases in permeation emissions increase evaporative VOC emissions. Systems that experience permeation can include the fuel systems of gasoline-powered motor vehicles, nonroad engines such as those used in lawn mowers and blowers, and watercraft. Permeation emissions are also associated with portable gasoline containers.

The materials submitted by the ARB to the U.S. EPA in February 2000 to support the waiver included estimates of the extent to which a waiver would decrease evaporative VOC emissions due to permeation losses from the use of ethanol-blended gasoline in on-road vehicles. These estimates of permeation losses were derived from the available fuel permeation data from two Society of Automotive Engineering (SAE) Technical Papers, 920163 and 970307. The ARB staff concluded that changing federal RFG gasoline in California from 2.0 wt.% oxygen from ethanol to nonoxygenated gasoline would reduce VOC evaporative emissions due to permeation from on-road vehicles by about 13 tpd.[18] Since about 60 percent of all federal RFG in California is sold in the SCAB, the reduction in VOC evaporative emissions from permeation in the SCAB would be about 7.8 tpd, assuming 100 percent penetration of nonoxygenated fuels.

In its analysis of California's waiver request, the U.S. EPA recognized the potential for increased permeation emissions when ethanol is added to gasoline. Acknowledging that "CARB's predicted increases are based on conservative estimates,"[19] the U.S. EPA incorporated the ARB's permeation estimates into the agency's overall analysis of the impacts of a waiver. The actual impact in any given waiver scenario would depend on the market share of nonoxygenated gasoline and the percentage of ethanol in gasoline. Table 27 of the U.S. EPA's TSD shows the decreases in permeation emissions under the 12 scenarios, which range from 3.7 to 8.5 tpd in the SCAB.[20] However, these estimates do not account for permeation from off-road sources. Since then two studies have been conducted to quantify permeation emissions from these sources.

The first study estimated the impact of ethanol gasoline on evaporative emissions from small engines such as lawnmowers, blowers, chainsaws, and other lawn and garden equipment (see Attachment 2)[21]. Based on the test results of five lawn mowers using commercial California gasoline containing 6 percent ethanol, evaporative emissions increased by up to 49 percent. Applying this factor to the approximately 20 tpd evaporative emissions from non-marine offroad engines statewide[22] results in about a 10 tpd evaporative emissions increase, or about a 4 tpd evaporative emissions increase in the SCAB.

The second study estimated the permeation emissions of storing ethanol gasoline in portable fuel containers (see Attachment 3)[23]. The study found that the additional evaporative emissions from portable fuel containers containing 10 vol.% ethanol in gasoline are about 8 tpd statewide. The test results also indicated that the presence of about 5.25 vol.% ethanol in gasoline increases permeation emissions from untreated containers by more than 60 percent, or about 5 tpd. This translates into an evaporative emissions increase of about 2 tpd for the SCAB.

Table 1 reflects the permeation emissions identified by U.S. EPA in Table 27 of the TSD, with additional columns representing permeation emissions from non-marine offroad engines and gasoline containers. These emissions values are derived from the

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[18] February 7, 2000 ARB submittal to U.S. EPA, Attachment at p. 19.
[19] TSD at 102
[20] TSD at 101
[21] California Air Resources Board, "Evaporative Emissions from Offroad Equipment," 2001.
[22] February 7, 2000 ARB submittal to U.S. EPA, Attachment (Table 4).
[23] California Air Resources Board, "Test Protocol and Results for the Determination of Permeation Rates from High Density Polyethylene Containers and Barrier Surface Treatment Feasibility Study," 2001.

two studies described above which showed that adding 5-6 percent ethanol to all gasoline would increase the SCAB permeation emissions from the additional sources by about 6.5 tpd.

Table 1 (Expansion of Table 27 in the TSD)
VOC Emission Reductions Due to Reductions of Permeation Losses with Waiver

					EPA's Permeation Emissions On-road Vehicles (VOC, tpd)			Additional Permeation Emissions Offroad Engines (VOC, tpd)		
No Wvr oxy wt.%	Wvr oxy wt.%	Nat'l MTBE Use	Unocal Patent	Non-oxy Penetration Pct.	Oxy no wvr to non oxy	Oxy no wvr to oxy wvr	Total	Oxy no wvr to non oxy	Oxy no wvr to oxy wvr	Total
2.0	2.0	Reduced	Applies	65	-5.1	0.0	-5.1	-2.6	0.0	-2.6
2.7	2.7	Reduced	Applies	60	-6.3	0.0	-6.3	-3.2	0.0	-3.2
2.7	2.0	Reduced	Applies	65	-6.8	-0.9	-7.8	-3.5	-0.5	-3.9
2.0	2.0	Continues	Applies	50	-3.9	0.0	-3.9	-2.0	0.0	-2.0
2.7	2.7	Continues	Applies	40	-4.2	0.0	-4.2	-2.1	0.0	-2.1
2.7	2.0	Continues	Applies	50	-5.3	-1.4	-6.6	-2.7	-0.7	-3.4
2.0	2.0	Reduced	Avoided	74	-5.8	0.0	-5.8	-2.9	0.0	-2.9
2.7	2.7	Reduced	Avoided	54	-5.7	0.0	-5.7	-2.9	0.0	-2.9
2.7	2.0	Reduced	Avoided	74	-7.8	-0.7	-8.5	-3.9	-0.4	-4.3
2.0	2.0	Continues	Avoided	50	-3.9	0.0	-3.9	-2.0	0.0	-2.0
2.7	2.7	Continues	Avoided	35	-3.7	0.0	-3.7	-1.9	0.0	-1.9
2.7	2.0	Continues	Avoided	50	-5.3	-1.4	-6.6	-2.7	-0.7	-3.4

It is noteworthy that the estimates in Table 1 do not include emissions from potentially significant sources, such as marine pleasure craft and fuel dispensing equipment. Thus the values in Table 1 are likely to still underestimate the full permeation impacts associated with the use of ethanol fuels.

In addition to the studies described above, the Coordinating Research Council (CRC) is currently conducting a permeation test program using fuel system components extracted from 10 California vehicles selected based on their contribution to the California on-road fleet. This study is designed to estimate the impact of ethanol in gasoline on permeation emissions from California motor vehicles based on the entire fuel system rather than individual components. The vehicle sample was chosen based on its representation of the model year distribution of motor vehicles within the California fleet. The final results of this study are not yet available but we expect they will be consistent with those of earlier permeation studies demonstrating that permeation emissions are significant and that the presence of ethanol in gasoline tends to increase emissions over what would be expected from a comparable fuels without ethanol.

B. The ARB's Assessment of the Real-World Impacts of Commingling California Phase 3 Reformulated Gasoline

1. *Overview of the Commingling Effect*

Adding ethanol to nonoxygenated gasoline results in a non-linear increase in RVP and the gasoline's propensity to evaporate. Essentially all of the RVP boost occurs by the time a gasoline mixture contains about 5 vol.% ethanol. At this blending level, the ethanol will have raised the RVP of the gasoline by about 1 psi. Because of this phenomenon, mixing ethanol-blended gasoline with nonoxygenated gasoline will increase the RVP of the resulting blend relative to the RVPs of the two gasoline components. For example, adding 10 gallons of gasoline that contains 6 vol.% ethanol and has an RVP of 7.0 psi to a vehicle fuel tank containing 10 gallons of nonoxygenated gasoline that has an RVP of 7.0 psi will result in a gasoline mixture having an RVP of about 7.5 psi. This boost in RVP is called the "commingling effect." Both the federal RFG and the CaRFG regulations generally prohibit suppliers of gasoline from mixing ethanol-blended gasoline with non-ethanol gasoline during the RVP season because of the commingling effect, but there are no restrictions on consumers commingling gasoline in a vehicle's fuel tank.

Without a waiver, all of the gasoline sold in the federal RFG areas in the state will contain at least 2 wt.% oxygen from ethanol – about 5.7 volume percent (vol.%) ethanol – once California's MTBE ban takes full effect in 2004. Under this circumstance, there would be no commingling effect for vehicles fueled only within the federal RFG areas. With a waiver, there will some emissions resulting from commingling because it is expected that some suppliers will offer gasoline that contains ethanol and others would not.

The effect of commingling on the average RVP in a given area depends on a number of variables in two basic areas – the gasoline market and consumer refueling habits. The two key gasoline market variables are the percentage of ethanol-blended gasoline in the marketplace, and the volume of ethanol in the ethanol blends. The key consumer habits are brand loyalty, fuel tank levels prior to refueling, fillup vs. non-fillup preference, and the quantity of gasoline purchased. Some of these variables can have a significant impact on the magnitude of the commingling effect on emissions. For instance, since gasoline stations will normally not switch from ethanol gasoline to nonoxygenated gasoline during the RVP season, there would generally be no commingling effect at all if all motorists maintained 100 percent brand loyalty. Similarly, the commingling effect would be minimal if motorists refueled only when their fuel tanks were almost empty.

In order to evaluate the size of the commingling effect in a particular area, one can use a computer model that will simulate the effect of consumer fuel purchasing decisions under a variety of assumed conditions. The inputs for the model consist of data and assumptions regarding gasoline marketing and data and assumptions regarding consumer refueling habits. The ultimate utility of a modeling exercise will depend on the validity of the data and assumptions and the soundness of the simulation model itself.

2. *The U.S. EPA's Commingling Analysis Used to Deny the Oxygen Waiver*

To support California's waiver request, the ARB submitted an estimate of the impact of the commingling effect based on a simulation model and a number of assumptions about the gasoline market and consumer refueling behavior. No actual refueling data were available for motorists in California's federal RFG areas or the rest of the state, so ARB staff based its assumptions on expected consumer habits. This analysis showed that there would be an average RVP increase of about 0.10 psi for all gasoline if fuel tanks were typically a quarter tank full at refueling, and an increase of about 0.13 psi if fuel tanks were typically half-full.

However, the U.S. EPA decided not to rely on the ARB staff's commingling assumptions, because "the conditions that would be applicable to the Federal RFG areas in California if a waiver were granted are largely unknown."[24] The agency instead turned to a commingling analysis that used a simulation model that had been published by U.S. EPA staff members Caffrey and Machiele in 1993[25] (the 1993 U.S. EPA Commingling Analysis). This analysis referred to two data sets pertaining to brand loyalty, which has the largest overall impact on the overall commingling effect. As discussed in Section V.B.4. below, the study authors made major adjustments to these data, which had been generated in 1981 and 1992. In its waiver consideration the U.S. EPA also cited the Sierra Research commingling analysis[26] that basically used the same U.S. EPA simulation model but applied the model specifically to California.

In its denial to California waiver request, the U.S. EPA stated "We believe, <u>in the absence of better information</u> that it is at least, if not more, reasonable to assume for waiver evaluation that the commingling effect would be around an average RVP increase of 0.2 pi rather than 0.1 pi." (TSD p. 110; emphasis added.) The agency further indicated that a "plausible case" could be made for average commingling effects as high as 0.3 pi.

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[24] TSD, p. 106.

[25] SAE paper 940765, "In-Use Volatility Impact of Commingling Ethanol and Non-Ethanol Fuels," Peter J. Caffrey and Paul A. Machiele, U.S. EPA.

[26] Sierra Research, "Potential Evaporative Emission Impacts Associated with the Introduction of Ethanol-Gasoline Blends in California," prepared for American Methanol Institute, Report # SR00-01-01, January 11, 2000.

3. *The ARB's Commingling Study*

The ARB staff has now completed a significantly new commingling study (the ARB Commingling Study) that provides recent data on California consumers fueling habits from observations of almost 400 fuelings. Using a probabilistic simulation model to process refueling information based on the newly collected data and ethanol market share assumptions, the ARB is now able to estimate that the likely commingling effect from a waiver is an average RVP increase of approximately 0.06 psi. The effect of this new information on U.S. EPA's earlier waiver analysis is shown in Section V.C. below.

The ARB's simulation modeling is reinforced by elements of the commingling study in which the RVP impacts from mixing different types of fuels were identified by sampling and testing the fuel in vehicle fuel tanks before and after fueling, as well as the fuel being dispensed. This analysis indicated a statewide average commingling impact of approximately 0.07 psi.

Both the simulation modeling and field sampling efforts are described in detail in Attachment 4 – the August 2003 Draft Report on the Assessment of the Real-World Impacts of Commingling California Phase 3 Reformulated Gasoline (the ARB Commingling Report). The overall study focused primarily on a comparison of the emission impacts from the CaRFG3 and CaRFG2 programs, to determine whether the emission benefits from the State's gasoline programs are being maintained. However, the staff also analyzed the data to address U.S. EPA's concerns about the commingling effect resulting from a waiver.

In the ARB Commingling Study, ARB staff observed motor vehicle fuelings at a total of 19 gasoline outlets in three areas of the State – the Los Angeles area, the San Francisco Bay Area, and Lake Tahoe. The latter area was included to increase the number of expected commingling events during field sampling, since the voluntary early phase-out of MTBE at Lake Tahoe meant that ethanol-blended fuels were much more prevalent there. The study included observations of 175 vehicle fuelings at Lake Tahoe, 121 in the Bay Area, and 100 in Los Angeles. Samples from the fuel tanks of 254 of these vehicles were also taken.

Brand loyalty was measured by asking each consumer if a different brand of gasoline was used for the last fueling of the vehicle. For purposes of the model, non-loyal consumers were assumed to be those who answered "yes" or "do not know." It was assumed that fueling by consumers characterized as "brand-loyal" resulted in no or negligible commingling occurring in their vehicle tanks. The other consumer refueling activities were accordingly included in the modeling analysis only for consumers who were not characterized as brand-loyal. Since there are major constraints on gasoline stations switching between non-ethanol and ethanol-blended gasoline during the summertime RVP season, a brand-loyal consumer can be expected receive the same type of fuel for every fueling.

The decision to characterize loyal consumers as those who purchased the same fuel brand in the last two fuelings was a consensus of the ARB/Industry working group that oversaw the study. The group believed that asking consumers regarding their brand loyalty from a history of previous fuelings beyond the last fueling might produce an unreliable answer. The loyalty levels showed in the ARB survey is consistent with the NPD survey data for California, taking into account that a brand switch would not necessarily produce commingling. In addition, the group hypothesized that most consumers would fuel at low tank levels, so only the remaining fuel from the last fueling, together with the dispensed fuel, would have a significant effect on the final fuel's RVP. This hypothesis was also consistent with the survey findings, where about 80 percent of consumers fueled at ¼ tank full gasoline or less, with more than 40 percent registering nearly an empty tank. Approximately half of consumers opted for a fillip. [See Attachment 4, pp. 21-23].

Table 1 shows the consumer fueling habits observed during the 2001 ARB field study.

Table 1. The 2001 ARB Data for Simulation Model Input*

Variables (All but Brand Loyalty Calculated for Non-Loyal Consumers Only)	**Lake Tahoe**	**S.F. Bay Area**	**Los Angeles**
Consumer Not Brand Loyal (%) [Includes "don't know" group]	69	42	38
Average Initial Fuel Tank Levels (as fraction of usable tank capacity)	0.23	0.2	0.18
Fillup (%)	52	58	24
Average Fuel Amount Purchased for Non-Fillup (as fraction of usable tank capacity)	0.35	0.32	0.37

*The model assumed 5% tank heel, derived from the SwRI's report [see footnote 26]

In selecting the anticipated market conditions to be used in the simulation modeling, ARB staff used the best available data, including recent reports and stakeholder consultations. Given the uncertainty, the staff concluded it was necessary to assume various scenarios that are expected to bracket a wide range of commingling impacts. As for ethanol market share, the staff assumed that the future California ethanol market share would vary from 25 to 65 percent. Modeling was accordingly conducted for nine different ethanol market share splits, reflecting the entire range from 25 to 65 percent, in five percent increments. This is consistent with the different scenarios developed by MathPro for U.S. EPA. The staff further assumed that the ethanol market share would be the same for all grades. After consulting with gasoline producers the staff assumed that the ethanol blends would be produced with either 6 vol.% or 7.7 vol.% ethanol; very little gasoline containing 10 vol.% ethanol has been marketed in California.

The data were analyzed by using the "UCD simulation model," developed by Dr. David Rocke at the University of California Davis. Inputting assumed future ethanol market conditions as well as consumer fueling behavior from the field study, ARB staff simulated a total of 162 fueling scenarios. Pertinent model results are provided on 45-49 of the ARB Commingling Report. As expected, the anticipated commingling effect increases with ethanol market penetration, and peaks at around 45 percent to 50 percent market share. For the base case scenario using a mid-range ethanol purchase propensity distribution, the model estimates average statewide commingling impacts of 0.055-0.069 psi RVP for 6 vol.% ethanol blends and 0.062-0.077 psi RVP for 7.7 vol.% ethanol blends.

Most if not all of the ethanol blends in California are expected to contain a maximum of 6 vol.% ethanol. Both the federal and California RFG requirements restrict the mixing of California reformulated blendstock for oxygen blending (RBOB or CARBOB) designed for one ethanol level with RBOB or CARBOB designed for another ethanol level. Coupled with the physical constraints on common carrier pipelines in the state, this means as a practical matter that pipeline-distributed gasoline will generally have the same amount of ethanol added. To date, the ethanol content has been around 5.7 vol.% – the minimum amount needed to achieve an oxygen content of 2.0 wt.%. Since this practice is expected to continue, it is appropriate to estimate the potential commingling effect based on ethanol levels of 6 vol.% in any waiver analysis.

4. *Reasons for the Differences in Results Between the U.S. EPA's Commingling Analysis and the ARB Commingling Study*

The differences in the results of the ARB commingling study and the U.S. EPA commingling analysis are due to a number of factors.

- **Modeling Assumptions**

The ARB analysis assumed negligible commingling impacts from brand loyal consumers. These brand loyal consumers got the same type of fuel, ethanol or non-oxygenate gasoline, since CaRFG3 regulations prohibit mixing two different types of gasoline in underground fuel tanks at retail stations. In addition, brand switching may not necessarily result in an RVP increase if the two brands are of the same fuel type.

In contrast, the U.S. EPA analysis assumed almost all consumers were not brand loyal, hence virtually every fueling event was associated with commingling that contributed to an RVP increase.

- **Data**

The 2001 ARB field study data were specific to California gasoline consumers. The study found that consumer fueling habits varied by region. Consumers in the urban areas (the Bay Area and Los Angeles) tended to be more brand loyal and to fuel at lower initial fuel tank levels than their counterparts in the rural areas (Lake Tahoe).

Though not as pronounced, some differences were also observed among consumers in the urban areas. The ARB analysis took into account these regional differences, and these detailed survey data allowed regional commingling impacts to be estimated separately. These estimates were then used to infer the statewide potential commingling impacts.

In contrast, the U.S. EPA data were not based on the current California consumers fueling habits. Therefore, the U.S. EPA data are a less reliable basis to assess the potential commingling impacts in California. In fact, the U.S. EPA's consumer fueling data were gathered from surveys conducted on different groups of consumers at various times and purposes, so they did not represent coherent information on any particular consumers. Aware of these shortcomings, the U.S. EPA purposely modified the data to ensure they produce a very conservative commingling impact. A commingling analysis based on such data is bound to predict a greater effect than is likely to occur.

Consumer Loyalty

Brand loyalty assumptions are of paramount importance, and the U.S. EPA indicated in the TSD that, "The magnitude of the commingling effect is highly sensitive to brand loyalty."[27] The 1993 U.S. EPA Commingling Analysis refers to two sets of data regarding brand loyalty. The primary set of data discussed in the analysis had been submitted by ARCO to U.S. EPA in 1981, and consisted of the following:

Brand Loyalty – 1981 ARCO Data

Percentage of Time Consumer Purchases Favorite Brand of Gasoline	Percent of Respondents in The Particular Category
0 – 25%	2
26 – 50%	12
51 – 75%	23
76 – 100%	63

[27] TSD, p. 112.

The other set of data was collected in 1992 by the NPD Group Inc. as part of its annual gasoline analysis prepared under contract with U.S. EPA. These data showed:

Brand Loyalty – 1992 NPD Group Data for Total U.S. Industry

Brand Grouping	Percentage
Use Many Different Brands	11.0%
Use 2 or 3 Brands	51.2%
Always Use One Brand	37.8%

The authors of the 1993 U.S. EPA Analysis concluded that the ARCO data “appeared to be unrealistic” because they “indicated a great propensity towards extremely high customer loyalty.” [SAE paper, p. 2]. The authors smoothed the data by shifting loyal consumers towards non-loyal consumers, and claimed these modified data were supported by the NPD data. This claim was inaccurate since the modified data showed practically no loyal consumers. As shown in the following table, several curves were used to fit the ARCO data, but none of them resembled the NPD data.

Modified Brand Loyalty from the Original 1981 ARCO Data

U.S. EPA Curve Fitting on ARCO Brand Loyalty Data	Loyal Consumers*
Fitted “Curve 2”	1%
Fitted “Curve 3”	1%
Fitted “Curve 4”	0%

*Always use one brand

The primary justification used by the authors for these curve fittings was that the ARCO data did not specifically specify the distribution of consumers in the 75%-100% loyalty range, but showed a lump sum of 63 percent of surveyed consumers fell in this range. Although this was true, they could have utilized the NPD data to determine the proportion of loyal consumers that “always use one brand,” since about 38 percent of the NPD consumers were in this category. As can be seen from the above table, the fitted curves dramatically distorted the proportion of loyal consumers, contrary to what the NPD data showed.

Also, the 1993 U.S. EPA Analysis failed to take into account the fact that brand loyalty data served as a surrogate to fuel type loyalty data. Ideally, the latter data should be used to model the commingling impact since brand switching may not result in an RVP boost if both brands sell the same fuel type. Although the authors recognize that “the loyalty curves the model uses are applicable only to a fuel brand and not a particular oxygenate,” [SAE paper, p.2] they again failed to utilize the NPD data that could have been used to conservatively estimate the proportion of non-loyal consumers that would not contribute to commingling. For example, if ethanol blends and non-oxygenated gasoline are equally distributed among four brands of gasoline from which non-loyal consumers, who use two brands equally, would choose, at least a third of these consumers would not experience an RVP boost from mixing two different gasoline brands in their vehicle tanks. Applying this estimate to the NPD data above and assuming consumers were equally distributed between using two and three brands, at least 8.5 percent of consumers would not contribute to an increase in emissions due to commingling of ethanol and non-ethanol fuels. Using the above reasoning for "use three brands" consumers, at a minimum another 5 percent of consumers would also not contribute to an increase in emissions due to commingling.

In summary, the U.S. EPA analysis assumed that essentially no brand loyal consumers exist, and that every brand switching resulted in commingling and produced an RVP increase. Both of these assumptions are unrealistic. All else being equal, the erroneous approach used by U.S. EPA could at least double the RVP increase.

Consumer Fueling Patterns and Tank Heel

The U.S. EPA analysis used a General Motors (GM) survey of about 1,100 refueling events to describe consumer fueling patterns, but it was not clear when and where the survey was conducted. The GM data showed that more than half of consumers fueled at 0.1 full tank or less. Rather than relying on mean and standard deviation of the data to fit a curve as called for in a standard statistical approach, the U.S. EPA, as in the consumer loyalty case, used an approach designed to inflate the commingling impact that had no scientific basis. As a result, the modified data indicated that most consumers fuel at a higher tank levels, with only about 40 percent of consumers fueling a tank that is 0.1 full or less. Moreover, the U.S. EPA assumed a tank heel of 10 percent tank capacity. It was not clear what was the source of this assumption, which appears to be too high. A Southwest Research Institute (SwRI) report on fuel tank flush effectiveness of five vehicles found that, on average, tank heel is about 5 percent of tank capacity.[28] Higher tank heel and initial tank levels mean that more fuel is left in the fuel tank to readily commingle with the dispensed fuel.

Similarly, for the dispensed fuel, the U.S. EPA smoothed the GM data that resulted in less amount added to vehicle fuel tank during fueling. This was done by reducing the fraction of consumers who refill to a full tank from more than 40 percent in the original GM data to only about 20 percent. The reduction of fillup frequency decreased the dilution effect of the dispensed fuel on the remaining fuel in vehicle tank, and therefore increased the RVP boost from the commingling.

In summary, as was the case with consumer loyalty, the U.S. EPA study authors modified the data on consumer refueling patterns and assumed an unreasonable high

[28] Southwest Research Institute, "A Vehicle Fuel Tank Flush Effectiveness Evaluation Program," prepared for Coordinating Research Council, Inc., SwRI Project 08-31088, August 20, 2001.

tank heel in a direction that increased the impact of commingling. Collectively, these two additional factors increased the commingling impacts by 20 to 30 percent.

- **Computer Model**

The ARB commingling study utilized a modeling method that can represent complex consumer fuel purchase decisions. Such an approach allows uncertainties in consumer decision-makings fully accounted for. The ARB study also included direct measurements of RVP increases in consumers' vehicle fuel tanks. The model produced commingling estimates that are consistent with the field measurements.

The computer model used in the U.S. EPA analysis employed an approach that did not allow random variations in fueling habits by consumers. For example, in simulating consumers' brand loyalty the model uses pre-determined values that were not randomly generated from any known statistical distribution. These values are biased toward non-loyal consumers. As a result, the model tended to overestimate the commingling impacts.

- **Corrected U.S. EPA Analysis**

If the U.S. EPA estimate of a likely 0.2 psi RVP increase from commingling is corrected due to reasons discussed above, the RVP increase would be less than 0.1 psi [i.e., 0.2 psi x 0.5 due to modified consumer loyalty x 0.75 due to modified consumer fueling patterns and tank heel]. This figure is more in line with the ARB estimate using the 2001 field survey in federal RFG areas in California as briefly described in the following section. Note: a critique by Dr. Gary Whitten also found that the U.S. EPA analysis overestimated the commingling effect. Dr. Whitten conclude that if the model used in the U.S. EPA analysis were adjusted to fix misrepresentations of the ARCO and GM data, the commingling effect is an RVP increase of about 0.07 psi.[29]

C. When the Additional Data on Permeation and Commingling Are Considered, it is Clear the Waiver Will Not Hinder Attainment and Maintenance of the Ozone NAAQS In California's Federal RFG Areas and There is Accordingly No Basis for Denial of the Waiver

In Table 31 of its TSD, U.S. EPA portrayed what it believed the range of possible exhaust and evaporative emissions impact of a waiver in the South Coast Air Basin under the 12 waiver scenarios that had been developed by MathPro. The table reflected the agency's various determinations and showed the VOC emissions impact of three RVP boost scenarios from commingling – no boost, an 0.1 psi boost, and an 0.2 psi boost. Adjustments to that table are needed to show the effect of the new information on permeation and commingling emissions. To illustrate what we believe an improved assessment would provide, ARB staff has prepared an Adjusted Table 31,

[29] Whitten, G.Z., "Analysis of Commingling due to Ethanol Blends," System Applications International, May 1999.

shown below, that reflects the new data being provided. The Adjusted Table 31 reflects the following modifications to the original table:

- An “0.06 psi RVP Boost” column has been substituted for the TSD’s three columns of “VOC no boost,” “VOC 0.1 psi boost,” and “VOC 0.2 boost.” The 0.06 RVP boost represents an average commingling impacts from 5.7 vol.% ethanol blend for various ethanol market shares in SCAB. The “0.06 RVP Boost” column includes all of the non-commingling VOC emissions shown in the original Table 31 “VOC no boost” column (including permeation emissions from on-road vehicles). Added to these VOC emissions are the commingling emissions from an 0.06 psi boost in RVP, derived by applying linear extrapolation to the sum of the on-road and nonroad “0.1 psi Commingling” columns in Table 32 of the TSD.

- A column for non-road permeation emissions has been added to reflect the new permeation data described above. Note that this excludes the impact of permeation emissions from pleasure craft.

- A new column has been added on the far right to show the total change of combined NOx and VOC.

Table 31: Waiver Impacts on Ozone (Revised)

				Waiver Case Oxygen Market Share and Oxy Levels			Emission Inventory Changes (tpd) (on-road, off-road and all Exhaust and evap VOC, such as permeation and commingling)				
No Wvr Oxy Level	Wvr Oxy Level	Nat'l MTBE Use	Unocal Patent	% Oxy Fuel	% Non-Oxy Fuel	Yr-round Oxy Ave	NOx	VOC 0.06 psi Boost	Off-road Permeation*	Total VOC	Total NOx+VOC
2.0	2.0	Reduced	Applies	35	65	1.0	-6.60	-0.08	-2.4	-2.48	-9.08
2.7	2.7	Reduced	Applies	40	60	1.5	-7.53	-11.59	-2.9	-14.49	-22.02
2.7	2.0	Reduced	Applies	35	65	1.0	-9.61	-12.58	-3.7	-16.28	-25.89
2.0	2.0	Continues	Applies	50	50	1.3	-5.08	-0.16	-1.8	-1.96	-7.04
2.7	2.7	Continues	Applies	60	40	1.9	-4.68	-5.99	-2.0	-7.99	-12.67
2.7	2.0	Continues	Applies	50	50	1.3	-8.21	-12.70	-3.1	-15.80	-24.01
2.0	2.0	Reduced	Avoided	26	74	0.9	-7.20	-5.23	-2.7	-7.93	-15.13
2.7	2.7	Reduced	Avoided	46	54	1.6	-7.08	-8.42	-2.7	-11.12	-18.20
2.7	2.0	Reduced	Avoided	26	74	0.9	-10.89	-11.88	-4.0	-15.88	-26.77
2.0	2.0	Continues	Avoided	50	50	1.3	-4.84	-4.35	-1.8	-6.15	-10.99
2.7	2.7	Continues	Avoided	65	35	2.0	-4.78	-5.62	-1.7	-7.32	-12.10
2.7	2.0	Continues	Avoided	50	50	1.3	-8.73	-11.06	-3.1	-14.16	-22.89

* Excluding marine pleasure craft and gasoline dispensing equipment

It can be seen from Adjusted Table 31 that NOx emissions decrease in all 12 scenarios, with the decrease ranging from approximately 5 tpd to 11 tpd. These impacts are unchanged from U.S. EPA's original analysis. VOC emissions also decrease in all scenarios. The combined emissions of NOx and VOC, as shown in the last column, range from about 7 to 27 tpd reductions.

It is important to understand the strengths and limitations of the scenarios used in the U.S EPA analysis. The fuel properties in each individual scenario were developed by MathPro Inc. and are based upon an extensive list of assumptions that may not accurately represent future operational characteristics of the California refining industry. For example, based upon a survey of California's refining industry, ARB staff found that overall sulfur concentrations for CaRFG3 would average about 10 ppm or less. Of the 24 different sets of CaRFG3 fuel properties generated for the U.S. EPA by MathPro Inc. over 70 percent are predicted to have sulfur concentrations of 10 ppm or higher. Also, MathPro Inc. used an input price of $25/Bbl for Saudi Light crude oil. In 2003, crude prices have consistently average about $30/Bbl. These departures from the original assumptions suggest that individual sets of fuel properties should not be relied upon to accurately assess the expected changes in emissions associated with a waiver, but should be used to determine the direction and magnitude of the changes.